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Research Article

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Physical properties of chilli growing soils of Khammam district

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Summary

Fifteen profiles from the chilli growing areas of the district were chosen for the study. Soil samples were collected horizon-wise and analysed for physical properties. The soil texture varied from sandy loam to clay loam in surface horizons and sandy clay loam to clay loam to clay in sub-surface horizons. Bulk density and particle density of soils varied from 1.37 to 1.66 and 2.44 to 2.60 Mg m^{-3}, respectively, the per cent aggregates greater than 0.25 mm and per cent aggregate stability ranged from 61.50 to 76.90, 48.40 to 64.60, respectively, hydraulic conductivity of the soils ranged from 0.08 cm hr^{-1} to 16.26 cm hr^{-1}, the infiltration was moderately rapid to moderately slow and slow, the water retention at 33 and 1500 K Pa was low, the available water content ranged from 4.21 per cent to 13.62 per cent and the available water storage capacity (cm m^{-1}) was low, medium to high.

Key words : Horizon-wise, Physical properties

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Introduction

Soil is the most important resource for agriculture and needs to be utilized precisely for sustainable crop production. The availability of land for agriculture has been reducing and is likely to touch the limit of 0.10 ha by 2025 (Sekhon and Velayutham, 2002). There is need to increase productivity of the soils to meet the requirement of increasing population.

Andhra Pradesh ranks first both in area and production of chillies in India, area under chillies in Khammam district is around 26,000 hectares with average yield of 3.6 t/ha.

Resource and Research Methods

The study was carried out with the objectives of physical properties of chilli growing soils of Khammam district of Andhra Pradesh. 15 profiles were studied in selected chilli growing areas by digging pits upto required depth. Horizon-wise soil samples were collected from the profiles for analysis of soil properties. Samples for physical analysis as required were collected. Infiltration was studied *in situ.*

The particle size analysis was carried out by hydrometer method, Munsell's colour chart was used to find out hue, value and chroma under dry and moist conditions (Soil Survey Staff, 1951), Bulk density was determined by core sampler method (Blake and Hartge, 1986), Aggregate analysis was done by wet sieving method as described by Yoder (1937). The saturated hydraulic conductivity of the undisturbed samples was

Table 1 : Physical properties of soils

Location	Depth (cm)	Gravel (%)	Sand (%)	Silt (%)	Clay (%)	Texture*	BD (Mg m^{-3})	PD (Mg m^{-3})	Porosity (%)	Per cent aggregates >0.25 mm	Aggregate stability (%)
Chintakani	0-15	27.20	76.40	11.00	12.60	sl	1.56	2.52	38.09	68.30	53.20
	15-22	36.30	66.40	11.00	22.60	scl	1.58	2.48	36.20	67.20	52.40
	22-70+	38.40	60.40	12.00	27.60	scl	1.61	2.51	35.80	61.50	51.10
Palvancha	0-20	11.60	58.40	12.00	29.60	cl	1.44	2.54	43.30	73.70	61.30
	20-35	13.20	54.40	14.00	31.60	cl	1.46	2.49	41.30	72.60	60.20
	35-65+	12.40	52.40	15.00	32.60	cl	1.48	2.56	42.10	74.80	59.90
Kusumanchi	0-15	25.60	74.40	8.00	17.60	sl	1.61	2.58	37.50	65.60	53.70
	15-30	31.20	56.40	8.00	25.60	scl	1.65	2.60	36.50	65.10	53.10
	30-45	35.60	63.40	9.00	27.60	scl	1.66	2.50	33.60	63.20	51.60
	45-90+	36.00	60.40	10.00	29.60	scl	1.66	2.50	33.60	62.40	48.40
Bhadrachalam	0-15	11.20	59.40	11.00	29.60	cl	1.40	2.55	45.60	76.60	64.10
	15-35	13.10	53.40	13.00	33.60	cl	1.41	2.52	44.00	75.20	62.50
	35-55	15.80	49.40	16.00	34.60	cl	1.45	2.48	41.50	75.10	62.10
	55-95+	16.20	41.40	19.00	39.60	c	1.48	2.52	41.20	72.40	59.40
Khammam rural	0-25	19.40	79.40	8.00	12.60	sl	1.58	2.48	36.20	69.70	53.20
	25-35	23.40	69.40	8.00	22.60	scl	1.62	2.46	34.10	69.10	50.10
	35-75+	32.50	63.40	9.00	27.60	scl	1.64	2.44	32.70	68.60	49.60
Chandrugonda	0-15	10.60	54.40	16.00	29.60	cl	1.44	2.56	43.70	76.90	63.30
	15-33	12.50	52.40	15.00	32.60	cl	1.48	2.58	42.60	75.70	62.30
	30-55	14.20	45.40	19.00	35.60	cl	1.51	2.49	39.30	75.10	60.20
	55-85+	16.80	43.40	19.00	37.60	cl	1.52	2.49	38.90	72.80	60.10
Wyra	0-15	12.40	55.40	15.00	29.60	cl	1.46	2.54	42.52	74.30	64.20
	15-33	14.50	51.40	15.00	33.60	cl	1.48	2.52	41.27	73.60	62.60
	33-65	18.60	48.40	16.00	35.60	cl	1.52	2.54	40.15	72.30	61.80
	65-105	19.40	43.40	17.00	39.60	c	1.52	2.53	39.92	71.20	59.30
Wazeedu	0-30	8.40	58.40	12.00	29.60	cl	1.46	2.55	42.70	73.80	64.60
	30-63	9.50	56.40	12.00	31.60	cl	1.48	2.52	41.20	72.10	62.60
	63-105	12.40	53.40	13.00	33.60	cl	1.48	2.53	41.50	70.80	61.20
Aswaraopeta	0-25	12.60	76.40	8.00	15.60	sl	1.56	2.58	39.50	70.70	54.10
	25-40	14.80	68.40	8.00	23.60	scl	1.61	2.54	36.60	70.20	53.20
	40-95+	14.60	63.40	9.00	27.60	scl	1.64	2.56	35.90	68.70	50.60
Burgampadu	0-20	12.50	58.40	10.00	31.00	cl	1.46	2.50	41.60	75.70	62.20

Table 1 : Contd.....

Table 1 : Contd

	20-35	14.00	54.40	13.00	32.60	cl	1.46	2.48	41.10	74.80	60.30
	35-55	18.20	47.40	17.00	35.60	cl	1.48	2.54	41.70	74.10	60.10
	55-80+	18.60	41.40	19.00	39.60	c	1.52	2.60	41.50	72.80	59.40
Julurupadu	0-15	12.80	73.40	9.00	17.60	sl	1.57	2.48	36.60	66.60	53.60
	15-32	14.70	65.40	9.00	25.60	scl	1.61	2.57	37.30	66.10	53.10
	32-75+	18.50	61.40	10.00	28.60	scl	1.62	2.56	36.70	65.20	51.20
Cherla	0-15	12.40	54.40	16.00	29.60	cl	1.37	2.48	44.70	74.60	63.30
	15-25	14.80	52.40	17.00	30.60	cl	1.42	2.57	44.70	74.80	61.20
	25-60	14.80	47.40	17.00	35.60	cl	1.46	2.55	42.70	74.40	60.80
	60-80	16.50	45.40	18.00	36.60	cl	1.46	2.60	43.80	72.80	60.10
Vararamachandrapuram	0-30	9.60	54.40	16.00	29.60	cl	1.48	2.53	41.50	72.60	61.70
	30-55	12.80	49.40	17.00	33.60	cl	1.52	2.49	38.90	71.10	60.90
	55-90+	14.00	47.40	16.00	36.60	cl	1.54	2.51	38.60	70.80	60.10
Singareni	0-15	32.50	75.40	9.00	15.60	sl	1.57	2.46	36.10	66.60	53.70
	15-35	41.50	66.40	10.00	23.60	scl	1.59	2.56	37.80	66.00	53.10
	35-65+	46.50	62.40	10.00	27.60	scl	1.61	2.55	36.80	64.20	51.60
Ashwapuram	0-25	8.50	52.40	16.00	31.60	cl	1.48	2.48	40.30	76.20	64.60
	25-48	9.00	49.40	17.00	33.60	cl	1.52	2.57	40.80	75.50	62.80
	48-95+	8.50	48.40	17.00	34.60	cl	1.54	2.55	39.60	75.20	62.10

* sl- Sandy loam, scl- Sandy clay loam, cl- Clay loam, c- Clay

determined by constant head method as outlined by Klute and Dirksen (1996), Infiltration rate was determined *in situ* by using double ring infiltrometer as described by Jalota *et al*. (1998) and water retention capacity of soil samples at 33 K Pa and 1500 K Pa tensions was determined using pressure plate apparatus (Klute and Dirksen, 1996).

Research Findings and Discussion

The gravel content in the soils varied from 8.40 per cent to 46.50 per cent, the sand content of the soils varied from 41.40 per cent to 79.40 per cent, higher fractions of sand could be attributed to dominance of physical weathering (Table 1). The sand content was higher in surface horizons which decreased with increase in depth. This is in conformity with the results reported by Gangopadhyay *et al*. (2001). The silt content varied from 8.0 per cent to 19.0 per cent, silt content increased with depth in all the profiles. The clay content of the soils varied from 12.60 per cent to 39.60 per cent, clay content increased with depth in all the profiles. The clay content in general, increased with depth. Gangopadhyay *et al*. (2001) reported that the clay content increases with increase in depth showing evidence of translocation of finer particles from surface to sub-surface horizons. The increase in clay content in lower horizons could be attributed to vertical migration of clay (Sarkar *et al*., 2002).

Sandy loam, sandy clay loam, clay loam and clay textures were observed in different horizons of the profiles. The variations in texture could be due to variations in weathering which is influenced by landscape position, soil environment and translocation of clay (Buol *et al*., 1998). Bulk density varied from 1.37 to 1.66 Mg m^{-3} in the horizons of the profiles. In general, surface layers had lower bulk density and it increased with depth. Low bulk density in surface layers could be due to higher organic matter content (Walia and Rao, 1996) and particle density of soils varied from 2.44 to 2.60 Mg m^{-3} in the horizons of profiles. Madhusudhana (1993) reported particle density varying from 2.48 to 2.65 Mg m^{-3} in soils of

Table 2 : Hydraulic properties of soil

Location	Depth (cm)	HC (cm hr^{-1})	Water retention (% w/w)		Available water content (% w/w)
			33 K Pa	1500 K Pa	
Chintakani	0-15	16.26	9.80	5.59	4.21
	15-22	6.60	13.17	7.50	5.67
	22-70+	4.70	14.60	8.00	6.60
Palvancha	0-20	3.26	16.24	8.10	8.14
	20-35	0.46	16.50	8.60	8.30
	35-65+	0.26	18.20	9.80	8.40
Kusumanchi	0-15	14.24	9.00	4.12	4.88
	15-30	8.64	14.75	8.18	6.57
	30-45	5.90	16.06	8.54	7.52
	45-90+	5.10	17.88	9.23	8.65
Bhadrachalam	0-15	2.26	21.10	11.40	9.70
	15-35	0.50	23.98	13.18	10.20
	35-55	0.32	25.72	14.10	11.62
	55-95+	0.24	27.44	15.20	12.24
Khammam rural	0-25	15.74	10.02	4.90	5.12
	25-35	8.60	14.60	8.56	6.04
	35-75+	5.25	15.80	9.34	6.46
Chandrugonda	0-15	1.64	23.40	12.60	10.80
	15-33	0.92	25.85	13.93	11.92
	30-55	0.68	27.00	14.20	12.80
	55-85+	0.45	30.22	17.10	13.12
Wyra	0-15	2.24	23.00	12.79	10.21
	15-33	0.35	24.60	13.10	11.50
	33-65	0.12	26.80	14.60	12.20
	65-105	0.08	30.72	17.80	12.92
Wazeedu	0-30	1.54	22.68	12.52	10.16
	30-63	0.68	26.50	14.68	11.82
	63-105	0.21	29.12	16.64	12.48
Aswaraopeta	0-25	15.42	10.06	4.96	5.10
	25-40	9.52	12.28	6.60	5.68
	40-95+	4.21	14.19	7.90	6.29
Burgampadu	0-20	3.80	22.80	12.46	10.34
	20-35	2.10	24.10	12.58	11.52
	35-55	0.59	28.20	16.44	11.76
	55-80+	0.08	29.66	17.36	12.30
Julurupadu	0-15	15.10	9.80	5.20	4.60
	15-32	9.20	14.20	7.00	7.20
	32-75+	5.10	15.10	7.48	7.62
Cherla	0-15	2.02	23.61	12.93	10.68
	15-25	0.81	25.71	13.85	11.86
	25-60	0.23	27.35	14.94	12.41
	60-80	0.21	28.96	15.34	13.62

Table 2 : Contd.……..

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Vararamachandrapuram	0-30	1.42	23.71	13.29	10.42
	30-55	0.58	26.10	14.78	11.32
	55-90+	0.22	29.20	16.78	12.42
Singareni	0-15	14.65	10.60	5.90	4.70
	15-35	9.52	13.92	8.50	5.42
	35-65+	7.53	15.12	8.80	6.32
Ashwapuram	0-25	1.52	24.62	14.31	10.31
	25-48	0.59	25.94	14.92	11.02
	48-95+	0.21	27.3	15.47	11.83

Chikicharla village of Andhra Pradesh. The porosity was higher in surface horizons and decreased with increase in depth. This could be due to more compaction of finer particles in deeper horizons resulting in reduced porosity (Jewitt *et al*., 1979).

The per cent aggregates greater than 0.25 mm were higher in the surface horizons. In general, the percentage decreased with depth. Higher per cent aggregates greater than 0.25 mm in surface soils could be attributed to higher organic carbon status. Rajyalakshmi (2004) reported significant correlation of organic carbon with per cent aggregates greater than 0.25 mm (r = 0.983) and the per cent aggregate stability in the soils also decreased with depth. Since aggregate stability is derived from the aggregates > 0.25 mm, similar trend with depth was observed. The factors discussed earlier which influenced aggregates > 0.25 mm also influenced aggregate stability.

Saturated hydraulic conductivity (Ks) of soils varied from 0.08 to 16.26 cm hr^{-1} in the horizons of the profiles (Table 2). The Ks was higher in surface horizons which decreased with increase in depth. The decrease could be attributed to increase in bulk density and clay content with increase in soil depth. Rajyalakshmi (2004) and Ramachandran (2006) reported decrease in hydraulic conductivity with depth.

The final infiltration rate in the soils varied from 0.3 to 7.3 cm hr^{-1} in the profiles (Table 3 and Fig.1). Infiltration was moderately rapid in Chintakani, Kusumanchi, Khammam rural, Aswaraopeta, Julurupadu and Singareni. It was moderately slow in Palvancha and Burgampadu and slow in other profiles. Infiltration reached more or less steady rate after 2 hours in all the profiles. The infiltration rates were high in the beginning and decreased with time. The decrease in infiltration could be attributed to higher clay content in sub-surface layers. Similar trend in infiltration rate with increasing clay

Table 3 : Infiltration rate and available water storage capacity of soils

Sr. No.	Location	Infiltration rate (cm hr^{-1})	Available water storage capacity (cm m^{-1})
1.	Chintakani	7.2	9.89
2.	Palvancha	0.6	14.11
3.	Kusumanchi	6.4	12.57
4.	Bhadrachalam	0.5	16.44
5.	Khammam rural	7.3	9.89
6.	Chandrugonda	0.3	18.79
7.	Wyra	0.3	18.11
8.	Wazeedu	0.4	17.06
9.	Aswaraopeta	6.8	9.55
10.	Burgampadu	0.6	17.44
11.	Julurupadu	6.4	11.49
12.	Cherla	0.4	16.66
13.	Vararamachandrapuram	0.3	17.54
14.	Singareni	6.3	9.44
15.	Ashwapuram	0.4	17.14

content down the depth was reported by Mathur *et al.* (1991). The decrease in infiltration rate with depth could also be attributed to increased bulk density in the sub-surface horizons Singa and Prabhu (1995). Water retention at 33 k Pa varied from 9.0 to 30.72 per cent (Table 2). The water retention was low in surface

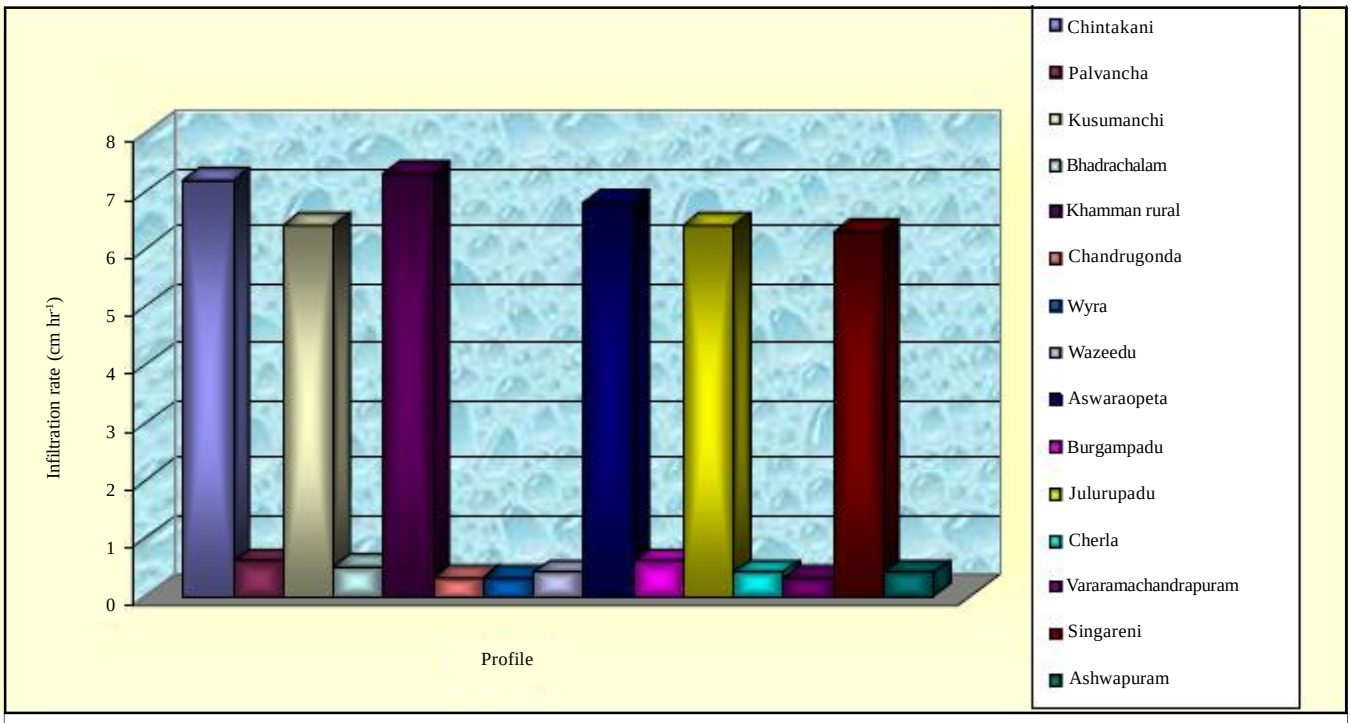

Fig. 1 : Infitration rate of soils

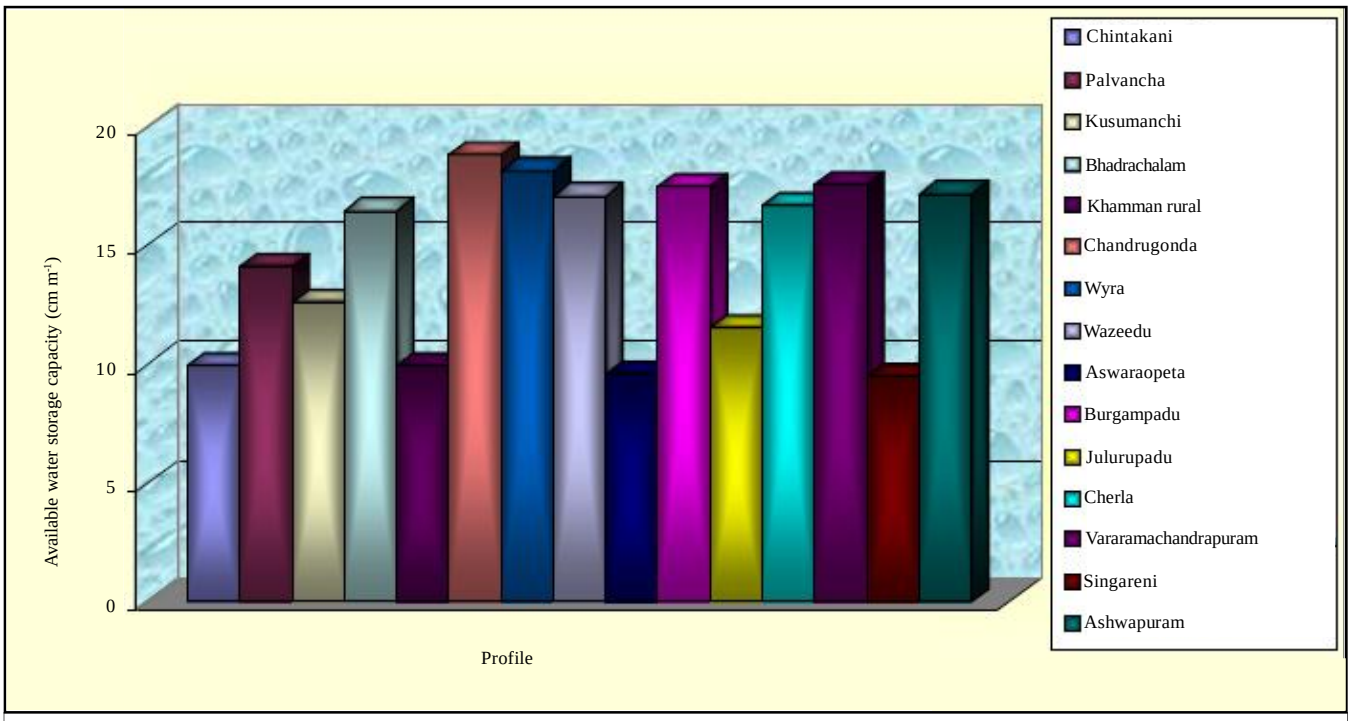

Fig. 2 : Available water storage capacity of soils

horizons and increased with increase in depth. The low water retention in surface horizons could be attributed to less clay content, more sand fraction, less CEC. With increase in clay content with depth, the water retention increased. Kumar *et al*. (2002) observed positive correlation between water retention and clay content.

The water retention at 1500 K Pa varied from 4.12 to 17.80 per cent in the soils. The water retention in the lower horizons increased with the increase in depth. This could be attributed to increase in clay content with depth. Vara *et al*. (2008) and Lingade *et al*. (2008) reported higher water retention due to increase in clay content with depth. The available water content varied from 4.21 to 13.62 per cent in the soils (Table 2) and available water content was low in surface horizons and increased with depth in almost all the profiles. This could be attributed to increase in clay content with depth Vara *et al*. (2008). The available water storage capacity of the profiles varied from 9.44 to 18.79 cm m^{-1} (Table 3 and Fig. 2). The AWSC (cm m^{-1} depth) of the profiles was low (5-10) in Chintakani, Khammam rural, Aswaraopeta and Singareni profiles. Medium (10-15) in Palvancha, Kusumanchi and Julurupadu and high (15-20) in Bhadrachalam, Chandrugonda, Wyra, Wazeedu, Burgampadu, Cherla, Vararamachandrapuram and Ashwapuram profiles. The soils high in clay content have exhibited high available water storage capacity. Maji *et al*. (2005) reported higher available water storage capacity with increase in clay, organic matter and depth in sub humid tropics of Central India.

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